AC-COUPLED — A connection which removes the constant voltage (DC component) on which the signal (AC component) is riding. Usually implemented by passing the signal through a capacitor.

AM — Amplitude Modulation (AM) is the process by which the amplitude of a high-frequency carrier is varied in proportion to the signal of interest. In the NTSC television system, AM is used to encode the color information and to transmit the picture.

Several different forms of AM are differentiated by filtering of the sidebands and whether or not the carrier is suppressed. Double sideband suppressed carrier is used to encode the NTSC color information, while the signal is transmitted with a vestigial sideband scheme.

APL — Average Picture Level. The average signal level (with respect to blanking) during active picture time, expressed as a percentage of the difference between the blanking and reference white levels.

BACK PORCH — The portion of the video signal which lies between the trailing edge of the horizontal sync pulse and the start of the active picture time. Burst is located on back porch.

BANDWIDTH — The range of frequencies over which signal amplitude remains constant (within some limit) as it is passed through a system.

BASEBAND — Refers to the composite video signal as it exists before modulating the picture carrier. Composite video distributed throughout a studio and used for recording is at baseband.

BLACK BURST — Also called "color black", black burst is a composite video signal consisting of all horizontal and vertical synchronization information, burst, and usually setup. Typically used as the house reference synchronization signal in television facilities.

BLANKING LEVEL — Refers to the 0 IRE level which exists before and after horizontal sync and during the vertical interval.

BREEZEWAY — The portion of the video signal which lies between the trailing edge of the horizontal sync pulse and the start of burst. Breezeway is part of back porch.

BROAD PULSES — Another name for the vertical synchronizing pulses in the center of the vertical interval. These pulses are long enough to be distinguished from all others, and are the part of the signal actually detected by vertical sync separators.

BURST — A small reference packet of the subcarrier sine wave, typically 8 or 9 cycles, which is sent on every line of video. Since the carrier is suppressed, this phase and frequency reference is required for synchronous demodulation of the color information in the receiver.

B-Y — One of the color difference signals used in the NTSC system, obtained by subtracting luminance from the blue camera signal. This is the signal which drives the horizontal axis of a vectorscope.

CHROMINANCE — Chrominance refers to the color information in a television picture. Chrominance can be further broken down into two properties of color: hue and saturation.

CHROMINANCE SIGNAL — The high-frequency portion of the video signal which is obtained by quadrature amplitude modulation of a 3.58 MHz subcarrier by R-Y and B-Y.

COLOR DIFFERENCE SIGNALS — Signals used by color television systems to convey color information in such a way that the signals go to zero when there is no color in the picture. R-Y, B-Y, I and Q are all color difference signals.

COMPONENT VIDEO — Video which exists in the form of three separate signals, all of which are required in order to completely specify the color picture. For example: R, G and B or Y, R-Y, and B-Y.

COMPOSITE VIDEO — A single video signal containing all of the necessary information to reproduce a color picture. Created by adding quadrature amplitude modulated R-Y and B-Y to the luminance signal.

CW — Continuous Wave. Refers to a separate subcarrier sine wave used for synchronization of chrominance information.

dB (DECIBEL) — A decibel is a logarithmic unit used to describe signal ratios. For voltages,

$$dB = 20\ Log_{10}\left(\frac{V1}{V2}\right)$$

DC-COUPLED — A connection configured so that both the signal (AC component) and the constant voltage on which it is riding (DC component) are passed through.

DC RESTORER — A circuit used in picture monitors and waveform monitors to clamp one point of the waveform to a fixed DC level.

DEMODULATOR — In general, this term refers to any device which recovers the original signal after it has modulated a high frequency carrier. In television, it may refer to:

(1) An instrument, such as a Tektronix TV1350 or 1450, which takes video in its transmitted form (modulated picture carrier) and converts it to baseband.

(2) The circuits which recover R-Y and B-Y from the composite signal.

EQUALIZER — The pulses which occur before and after the broad pulses in the vertical interval.

ENVELOPE DETECTION — A-demodulation process in which the shape of the RF envelope is sensed. This is the process used by a diode detector.

FIELD — In interlaced scan systems, the information for one picture is divided up into two fields. Each field contains one half of the lines required to produce the entire picture. Adjacent lines in the picture are in alternate fields.

FM — Frequency Modulation (FM) is the process by which the frequency of a carrier signal is varied in proportion to the signal of interest. In the NTSC television system, audio information is transmitted using FM.

FRAME — A frame contains all the information required for a complete picture. For interlaced scan systems, there are two fields in a frame.

FRONT PORCH — The portion of the video signal between the end of active picture time and the leading edge of horizontal sync.

GAMMA — Since picture monitors have a nonlinear relationship between the input voltage and brightness, the signal must be correspondingly predistorted. Gamma correction is always done at the source (camera) in television systems: the R, G and B signals are converted to R 1/g , G 1/g and B 1/g. Values of about 2.2 are typically used for gamma.

GENLOCK — The process of locking both sync and burst of one signal to sync and burst of another, making the two signals completely synchronous.

GRATICULE — The scale which is used to quantify the information on a waveform monitor or vectorscope display. Graticules may either be screened onto the faceplate of the CRT itself (internal graticule), or onto a piece of glass or plastic which fits in front of the CRT (external graticule). They can also be electronically generated.

HARMONIC DISTORTION — If a sine wave of a single frequency is put into a system, and harmonic content at multiples of that frequency appears at the output, there is harmonic distortion present in the system. Harmonic distortion is caused by nonlinearities in the system.

HORIZONTAL BLANKING — Horizontal blanking is the entire time between the end of the active picture time of one line and the beginning of active picture time of the next line. It extends from the start of front porch to the end of back porch.

HORIZONTAL SYNC — Horizontal sync is the -40 IRE pulse occurring at the beginning of each line. This pulse signals the picture monitor to go back to the left side of the screen and trace another horizontal line of picture information.

HUE — Hue is the property of color which allows us to distinguish between colors such as red, yellow, purple, etc.

HUM — Undesirable coupling of the 60 Hz power sine wave into other electrical signals.

INTERCARRIER SOUND — A method used to recover audio information in the NTSC system. Sound is separated from video by beating the sound carrier against the video carrier, producing a 4.5 MHz IF which contains the sound information.

IRE — A unit equal to 1/140 of the peak-to-peak amplitude of the video signal, which is typically one volt. The 0 IRE point is at blanking level, with sync tip at -40 IRE and white extending to +100 IRE. IRE stands for Institute of Radio Engineers, the organization which defined the unit.

LINEAR DISTORTION — Refers to distortions which are independent of signal amplitude.

LUMINANCE — The signal which represents brightness, or the amount of light in the picture. This is the only signal required for black and white pictures, and for color systems it is obtained as a weighted sum (Y = 0.3R + 0.59G + 0.11B) of the R, G and B signals.

MODULATED — When referring to television test signals, this term implies that chrominance information is present. (For example, a modulated staircase has subcarrier on each step.)

MODULATION — A process which allows signal information to be moved to other frequencies in order to facilitate transmission or frequency-domain multiplexing. See AM and FM for details.

NONLINEAR DISTORTION — Refers to distortions which are amplitude-dependent.

NTSC — National Television System Committee. The organization which developed the television standard currently in use in the United States, Canada and Japan. Now generally used to refer to that standard.

PAL — Phase Alternate Line. Refers to the television system used in Europe and many other parts of the world. The phase of the chrominance signal alternates from line to line to help cancel out phase errors.

QUADRATURE AM — A process which allows two different signals to modulate a single carrier frequency. The two signals of interest Amplitude Modulate carrier signals which are the same frequency but differ in phase by 90 degrees (hence the Quadrature notation). The two resultant signals can be added together, and both signals recovered at the other end, if they are also demodulated 90 degrees apart.

QUADRATURE DISTORTION — Distortion resulting from the asymmetry of sidebands used in vestigial sideband television transmission. Quadrature distortion appears when envelope detection is used, but can be eliminated by using a synchronous demodulator.

RF — Radio Frequency. In television applications, RF generally refers to the television signal after the picture carrier modulation process.

RGB — Red, Green and Blue. The three primary colors used in color television's additive color reproduction system. These are the three color signals generated by the camera and used by the picture monitor to produce a picture.

R-Y — One of the color difference signals used in the NTSC system, obtained by subtracting luminance from the red camera signal. The R-Y signal drives the vertical axis of a vectorscope.

SATURATION— The property of color which relates to the amount of white light in the color. Highly saturated colors are vivid, while less saturated colors appear pastel. For example, red is highly saturated, while pink is the same hue but much less saturated.

SETUP — In NTSC systems, video black is typically 7.5 IRE above the blanking level. This 7.5 IRE level is referred to as the black setup level, or simply as setup.

SUBCARRIER — The modulation sidebands of the color subcarrier contain the R-Y and B-Y information. For NTSC, subcarrier frequency is 3.579545 MHz.

SYNCHRONOUS DETECTION — A demodulation process in which the original signal is recovered by multiplying the modulated signal with the output of a synchronous oscillator locked to the carrier.

TERMINATION — In order to accurately send a signal through a transmission line, there must be an impedance at the end which matches the impedance of the source and of the line itself. Amplitude errors and reflections will otherwise result. Video is a 75 Ohm system, so a 75 Ohm terminator must be put at the end of the signal path.

UNMODULATED — When used to describe television test signals, this term refers to pulses and pedestals which do not have high-frequency chrominance information added to them.

VECTORSCOPE — A specialized oscilloscope which demodulates the video signal and presents a display of R-Y versus B-Y. The angle and magnitude of the displayed vectors are respectively related to hue and saturation.

VERTICAL INTERVAL — The synchronizing information which appears between fields and signals the picture monitor to go back to the top of the screen to begin another vertical scan.

WAVEFORM MONITOR — A specialized oscilloscope for evaluating television signals.

Y — Abbreviation for luminance.

ZERO CARRIER REFERENCE — A 120 IRE pulse in the vertical interval which is produced by the demodulator to provide a reference for evaluating depth of modulation.

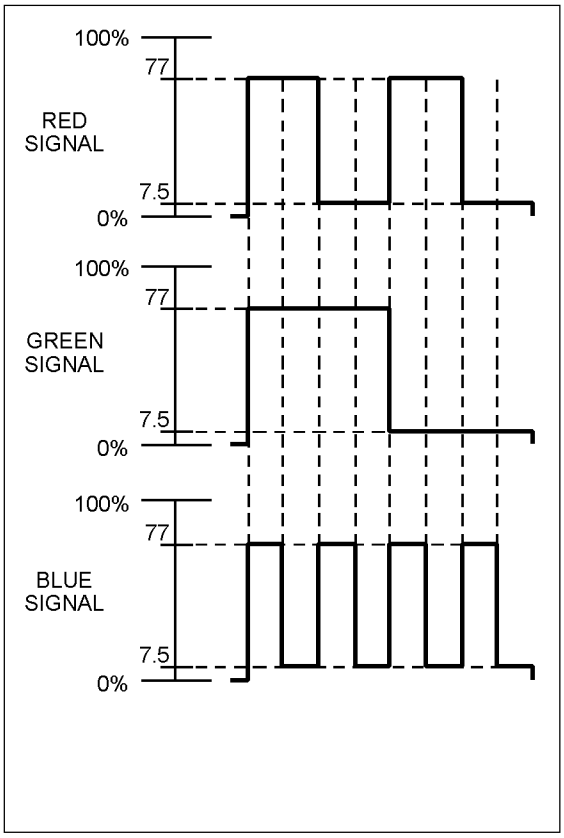


Figure 110. RGB levels decoded from 75% bars with 75% white.

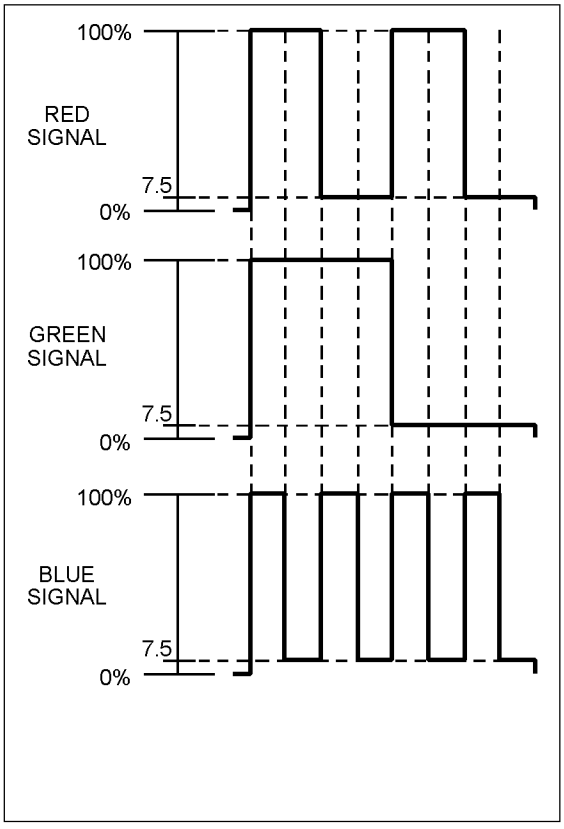


Figure 111. RGB levels decoded from 100% bars with 100% white.

There are two basic types of NTSC color bar signals in common use. The terms "75% bars" and "100% bars" are generally used to distinguish between the two types. While this terminology is widely used, there is often confusion about exactly which parameters the 75% versus 100% notation refers to.

RGB Amplitudes. The 75%/100% nomenclature specifically refers to the maximum amplitudes reached by the Red, Green, and Blue signals when they form the six primary and secondary colors required for color bars. For 75% bars, the maximum amplitude of the RGB signals is 75% of the peak white level. For 100% bars, the RGB signals can extend up to 100% of peak white (see Figures 110 and 111).

Saturation. Both 75% and 100% amplitude color bars are 100% saturated. In the RGB format, colors are saturated if at least one of the primaries is at zero. Note in Figures 110 and 111 that the zero signal level is at setup (7.5 IRE) for NTSC.

The Composite Signal. In the composite signal, both chrominance and luminance amplitudes vary according to the 75%/100% distinction. However, the ratio between chrominance and luminance amplitudes remains constant in order to maintain 100% saturation (see Figures 112 and 113).

White Bar Levels. Color bar signals can also have different white bar levels, typically either 75% or 100%. This parameter is completely independent of the 75%/100% amplitude distinction and either white level may be associated with either type of bars.

Effects of Setup. Because of setup, the 75% signal level for NTSC is at 77 IRE. The maximum available signal amplitude is 100 - 7.5, or 92.5 IRE. 75% of 92.5 IRE is 69.4 IRE, which when added to the 7.5 IRE pedestal, yields a level of approximately 77 IRE.

Note in Figure 110 that the 75% white bar and the 75% RGB signals extend to 77 IRE.

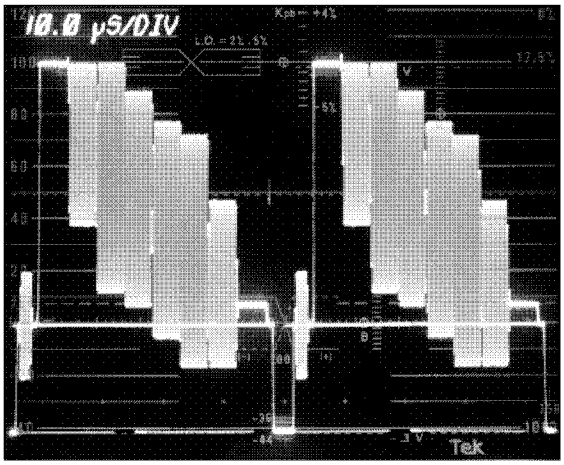


Figure 112. 75% bars with 100% white.

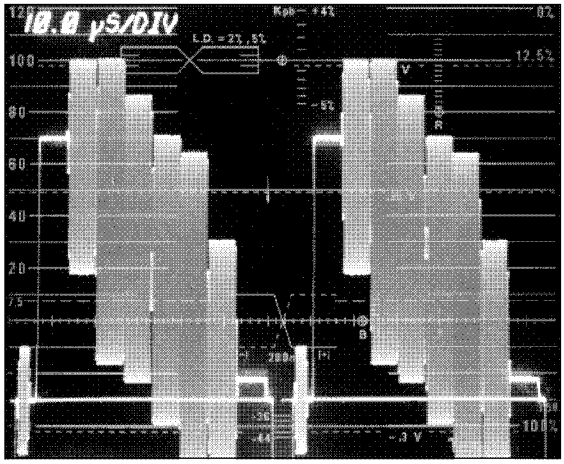


Figure 113. 100% bars with 100% white.

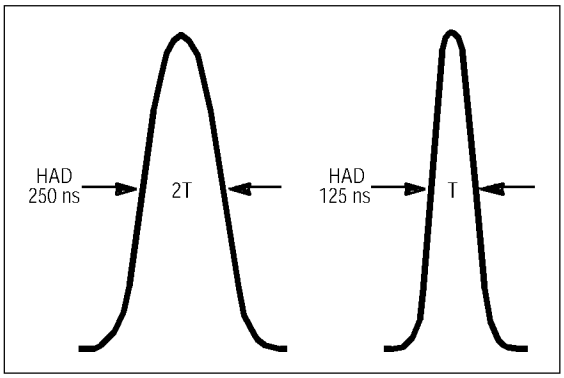


Figure 114. 2T pulse and 1T pulse for NTSC systems.

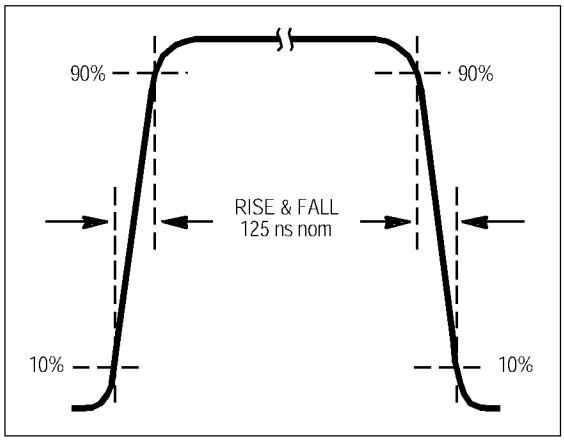


Figure 115. T rise time step.

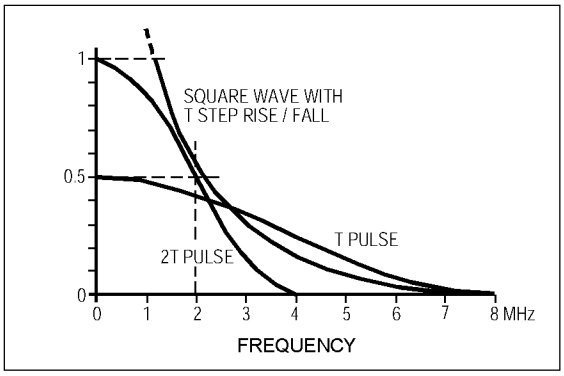


Figure 116. Frequency spectra of T pulse, 2T pulse, and T step.

Testing Bandlimited Systems. Fast rise time square waves cannot be used for testing bandwidth limited systems as attenuation and phase shift of out-of-band components will cause ringing in the output pulse. These out-of-band distortions can obscure the in-band distortions of interest. Sine-squared pulses are themselves bandwidth limited, and are thus useful for testing bandwidth limited television systems.

Description of the Pulse. The sine-squared pulse looks like one cycle of a sine wave (see Figure 114). Mathematically, a sine-squared pulse is obtained by squaring a half-cycle of a sine wave. Physically, the pulse is generated by passing an impulse through a sine-squared shaping filter.

T Intervals. Sine-squared pulses are specified in terms of half amplitude duration (HAD) which is the pulse width measured at 50% of the pulse amplitude.

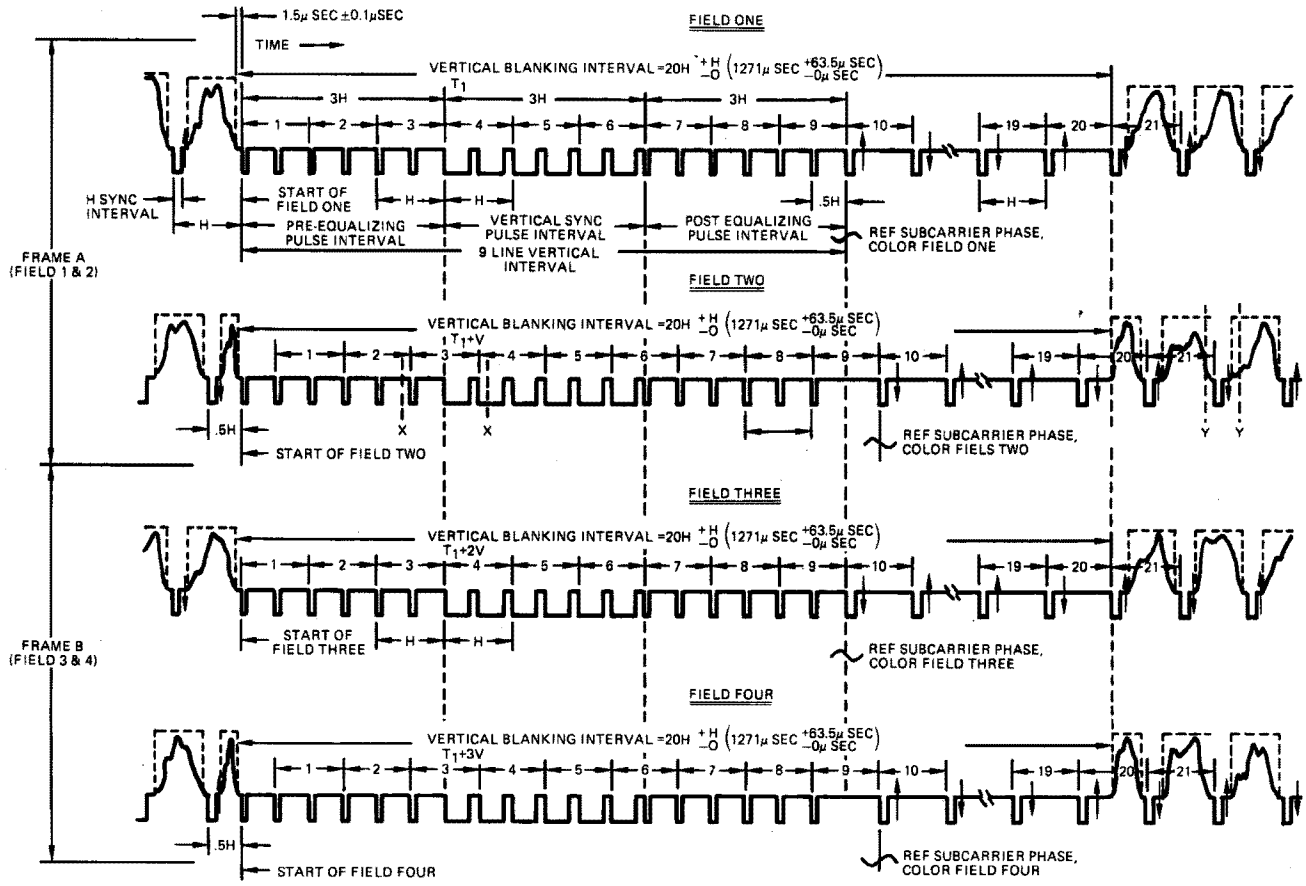
Pulses with a HAD that is a multiple of the time interval T are used to test bandwidth limited systems. T, 2T and 12.5T pulses are common examples. T is the Nyquist interval, or

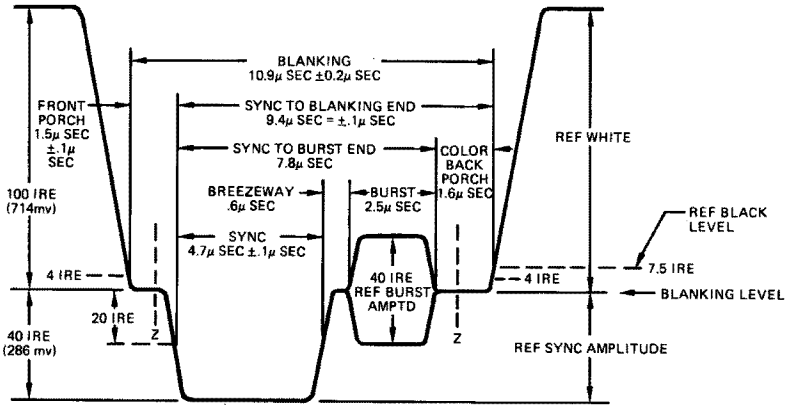
$$\frac{1}{2f_c}$$

where fc is the cutoff frequency of the system to be measured. For NTSC, fc is taken to be 4 MHz and T is therefore 125 nanoseconds.

T Steps. The rise times of transitions to a constant luminance level (such as a white bar) are also specified in terms of T. A T step has a 10% to 90% rise time of nominally 125 nanoseconds while a 2T step has a rise time of nominally 250 nanoseconds (see Figure 115). Mathematically, a T step is obtained by integrating a sine-squared pulse. Physically, it is produced by passing a step through a sine-squared shaping filter.

Energy Distribution. Sine-squared pulses possess negligible energy at frequencies above f = 1/HAD. The amplitude of the envelope of the frequency spectrum at 1/(2 HAD) is one-half of the amplitude at zero frequency. Energy distributions for a T pulse, 2T pulse, and T step are shown in Figure 116.


1.5μ SEC ±0.1μSEC
TIME
FIELD ONE
VERTICAL BLANKING INTERVAL=20H +H −0 (1271μ SEC +63.5μ SEC −0μ SEC)
T1
3H
H SYNC INTERVAL
START OF FIELD ONE
PRE-EQUALIZING PULSE INTERVAL
VERTICAL SYNC PULSE INTERVAL
9 LINE VERTICAL INTERVAL
POST EQUALIZING PULSE INTERVAL
.5H
REF SUBCARRIER PHASE, COLOR FIELD ONE
FRAME A (FIELD 1 & 2)
FIELD TWO
T1+V
START OF FIELD TWO
REF SUBCARRIER PHASE, COLOR FIELS TWO
FIELD THREE
T1+2V
START OF FIELD THREE
REF SUBCARRIER PHASE, COLOR FIELD THREE
FRAME B (FIELD 3 & 4)
FIELD FOUR
T1+3V
START OF FIELD FOUR
REF SUBCARRIER PHASE, COLOR FIELD FOUR


BLANKING 10.9μ SEC ±0.2μ SEC
SYNC TO BLANKING END 9.4μ SEC = ±.1μ SEC
SYNC TO BURST END 7.8μ SEC
FRONT PORCH 1.5μ SEC ±.1μ SEC
COLOR BACK PORCH 1.6μ SEC
REF WHITE
100 IRE (714mv)
BREEZEWAY .6μ SEC
BURST 2.5μ SEC
SYNC 4.7μ SEC ±.1μ SEC
REF BLACK LEVEL
7.5 IRE
4 IRE
40 IRE REF BURST AMPTD
BLANKING LEVEL
20 IRE
40 IRE (286 mv)
REF SYNC AMPLITUDE

DETAIL YY

APPENDIX C - RS-170A

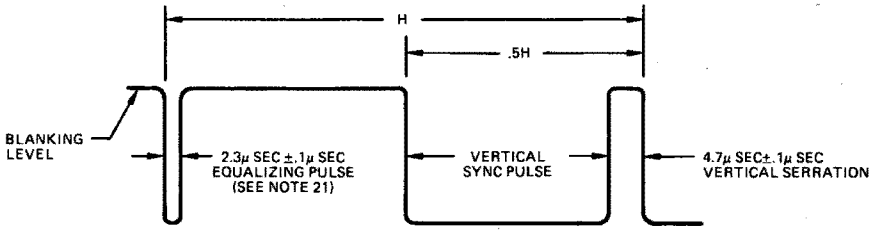
NTSC Standard

NOTES:

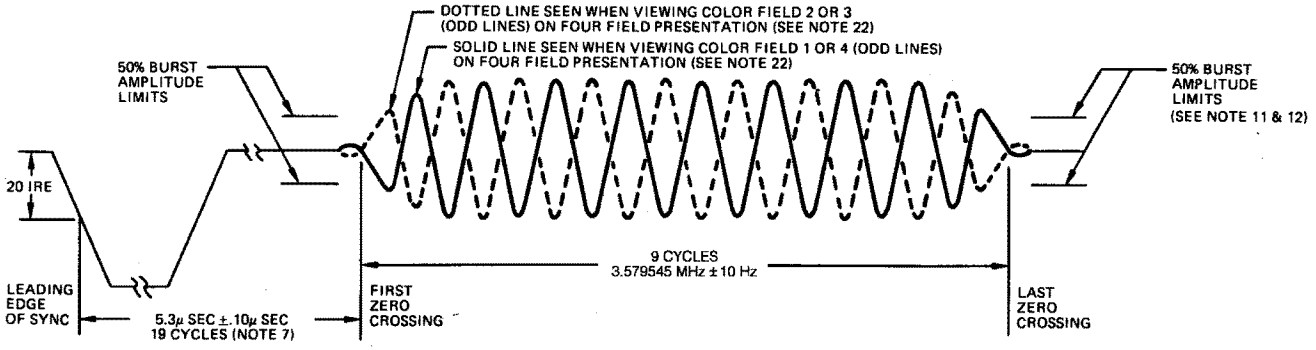
1. SPECIFICATIONS APPLY TO STUDIO FACILITIES. NETWORK AND TRANSMITTER CHARACTERISTICS ARE NOT INCLUDED.
2. ALL TOLERANCES AND LIMITS SHOWN IN THIS DRAWING PERMISSABLE ONLY FOR LONG TIME VARIATIONS.
3. BURST FREQUENCY SHALL BE 3.579545 MHz ±10 Hz.
4. HORIZONTAL SCANNING FREQUENCY SHALL BE 2/455 TIMES THE BURST FREQUENCY.
5. VERTICAL SCANNING FREQUENCY SHALL BE 2/525 TIMES THE HORIZONTAL SCANNING FREQUENCY.
6. START OF COLOR FIELDS ONE AND THREE IS DEFINED BY A WHOLE LINE BETWEEN THE FIRST EQUALIZING PULSE AND THE PRECEDING H SYNC PULSE. START OF COLOR FIELDS TWO AND FOUR DEFINED BY A HALF LINE BETWEEN THE FIRST EQUALIZING PULSE AND THE PRECEDING H PULSE. COLOR FIELD ONE IS THAT FIELD WITH POSITIVE GOING ZERO-CROSSINGS OF REFERENCE SUBCARRIER NOMINALLY COINCIDENT WITH 50% AMPLITUDE POINT OF THE LEADING EDGES OF EVEN NUMBERED HORIZONTAL SYNC PULSES.
7. THE ZERO-CROSSINGS OF REFERENCE SUBCARRIER SHALL BE NOMINALLY COINCIDENT WITH THE 50% POINT OF THE LEADING EDGES OF ALL HORIZONTAL SYNC PULSES. FOR THOSE CASES WHERE THE RELATIONSHIP BETWEEN SYNC AND SUBCARRIER IS CRITICAL FOR PROGRAM INTEGRATION, THE TOLERANCE ON THIS COINCIDENCE IS ±45° OF REFERENCE SUBCARRIER.
8. ALL RISE TIMES AND FALL TIMES UNLESS OTHERWISE SPECIFIED ARE TO BE 0.140 μSEC ±0.02 μSEC MEASURED FROM TEN TO NINETY PER CENT AMPLITUDE POINTS. ALL PULSE WIDTHS EXCEPT BLANKING ARE MEASURED AT FIFTY PER CENT AMPLITUDE POINT.
9. OVERSHOOT ON ALL PULSES DURING SYNC AND BLANKING (VERTICAL AND HORIZONTAL) SHALL NOT EXCEED TWO IRE UNITS. ANY OTHER EXTRANEOUS SIGNALS DURING BLANKING INTERVALS SHALL NOT EXCEED TWO IRE UNITS, MEASURED OVER A BANDWIDTH OF 6 MHz.
10. BURST ENVELOPE RISE TIME IS 0.30 μSEC MEASURED BETWEEN THE TEN AND NINETY PERCENT AMPLITUDE POINTS. IT SHALL HAVE THE GENERAL SHAPE SHOWN.
11. THE START OF BURST IS DEFINED BY THE ZERO-CROSSING (POSITIVE OR NEGATIVE SLOPE) THAT PRECEEDS THE FIRST HALF CYCLE OF SUBCARRIER THAT IS 50% OR GREATER OF THE BURST AMPLITUDE.
12. THE END OF BURST IN DEFINED BY THE ZERO-CROSSING (POSITIVE OR NEGATIVE SLOPE) THAT FOLLOWS THE LAST HALF CYCLE OF SUBCARRIER THAT IS 50% OR GREATER OF THE BURST AMPLITUDE.
13. MONOCHROME SIGNALS SHALL BE IN ACCORDANCE WITH THIS DRAWING EXCEPT THAT BURST IS OMITTED, AND FIELDS THREE AND FOUR ARE IDENTICAL TO FIELDS ONE AND TWO RESPECTIVELY.
14. REFERENCE SUBCARRIER IS A CONTINUOUS SIGNAL WHICH HAS THE SAME INSTANTANEOUS PHASE AS BURST.
15. PROGRAM OPERATING LEVEL WHITE IS 100 IRE, +0, −2 IRE.
16. PROGRAM OPERATING LEVEL BLACK IS 7.5 IRE, ±2.5 IRE.
17. PROGRAM OPERATING LEVEL SYNC IS 40 IRE, ±2 IRE.
18. PROGRAM OPERATING LEVEL BURST IS 40 IRE, ±2 IRE.
19. BURST PEDESTAL NOT TO EXCEED ±2 IRE.
20. BREEZEWAY, BURST, COLOR BACK PORCH, AND SYNC TO BURST END ARE NOMINAL IN DETAIL BETWEEN YY. SEE DETAIL BETWEEN ZZ FOR TOLERANCES.
21. RATIO OF AREA OF VERTICAL EQUALIZING PULSE TO SYNC PULSE SHALL BE WITHIN 45 TO 50 PER CENT.
22. THERE WILL BE A 100 DEGREE REVERSAL OF PHASE WHEN VIEWING EVEN LINES ON A FOUR FIELD PRESENTATION. A FOUR FIELD PRESENTATION MEANS A DISPLAY DEVICE WHICH IS TRIGGERED BY FOUR FIELD (15 Hz) INFORMATION.

THIS DRAWING CORRESPONDS TO PROPOSED RS 170A VIDEO STANDARD.

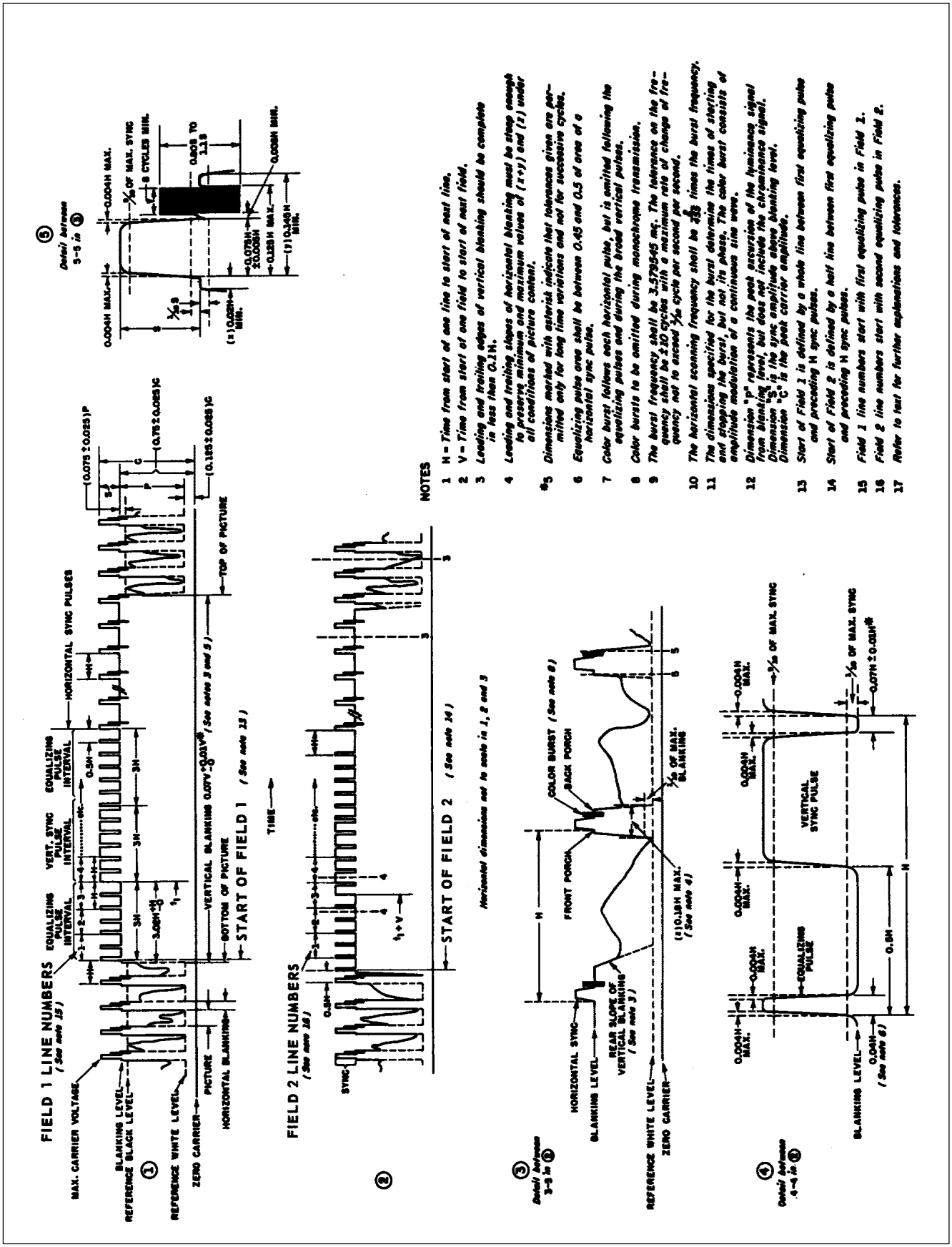
COLOR TIMING DATA:
1° = .776 ns
INS = 1.289°
FOR CABLE WITH 66% PROPAGATION FACTOR,
1° = 6.035" = .503'
INS = 7.778" = .648'



DETAIL XX



DETAIL ZZ


FIELD 1 LINE NUMBERS
FIELD 2 LINE NUMBERS
START OF FIELD 1
START OF FIELD 2
TOP OF PICTURE
BOTTOM OF PICTURE
MAX. CARRIER VOLTAGE
BLANKING LEVEL
REFERENCE BLACK LEVEL
REFERENCE WHITE LEVEL
ZERO CARRIER
PICTURE
HORIZONTAL BLANKING
VERTICAL BLANKING
EQUALIZING PULSE INTERVAL
VERT. SYNC PULSE INTERVAL
HORIZONTAL SYNC PULSES
TIME
SYNC
FRONT PORCH
COLOR BURST
BACK PORCH
REAR SLOPE OF VERTICAL BLANKING
EQUALIZING PULSE
VERTICAL SYNC PULSE
NOTES

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